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Percutaneous Endoscopic Gastrostomy

Initial Placement by Single Endoscopic Technique and Long-Term Follow-up

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Of 598 patients, 595 underwent placement of a percutaneous endoscopic gastrostomy (PEG) tube using a single endoscopy technique and a polyurethane gastrostomy tube. Primary indications were altered mental status and dysphagia. All procedures were performed in the operating room, with 74 patients receiving general anesthesia and 524 intravenous sedatives with or without topical anesthesia. Average operating room time was 34 minutes. Of 208 patients with prior intra-abdominal surgery, 207 underwent successful placement. The overall complication rate was 4.9%, with a major complication rate of 1.3%. One death occurred from presumed leakage at the gastrostomy site with peritonitis. One hundred twenty patients subsequently died of causes unrelated to the gastrostomy tube after 75 ± 164 days (range, 1 to 972). One hundred fifty-four patients recovered an adequate oral diet and had the PEG removed after 169 ± 244 days (range, 6 to 1337). The remaining 319 patients continued to use their gastrostomy tube for 1532 ± 411 days (range, 134 to 2251). The polyurethane gastrostomy tube has been very durable; none has required replacement because of deterioration.

Since its introduction in 1980 by Gauderer et al.,[1] the percutaneous endoscopic technique for placing a feeding gastrostomy tube has rapidly gained popularity because of its ease and safety of placement. The initial publications used a double endoscopy technique and a modified Mushroom or Malecot rubber tube. This report reviews just over 7 years' experience using a single endoscopic technique and a polyurethane gastrostomy tube in 598 patients.

METHODS

Patient Selection

Between January 1985 and March 1992, 598 patients were referred to the Surgical Service at Duke University Medical Center for placement of a percutaneous feeding gastrostomy tube (335 males and 263 females). The indication for feeding access was altered mental status, mainly due to stroke, head injury, or brain tumor (389 patients); and swallowing difficulty, mainly due to head and neck cancer, radiation therapy, or stroke (209 patients). The average age was 61 ± 18 years (range, 16 to 91 years). Many patients had serious concomitant medical illnesses, as shown in Table 1 and as reflected by the average assigned American Society of Anesthesiology risk factor (ASA) of 3.0 on a scale of 1 to 5 (287 patients with ASA = 3—severe systemic disease limiting activity; 150 with ASA = 4—incapacitating systemic disease threatening life; and 2 with ASA = 5—critically ill with little chance of survival).

Gastrostomy Tube

A 20F polyurethane gastrostomy tube specially designed for percutaneous placement was used (Biosearch

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Table 1. MEDICAL PROBLEMS THAT INCREASE ANESTHETIC RISKS

Problem	% of Patients
Cardiac disease (myocardial infarction, arrhythmias, hypertension)	18
Pulmonary disease (respiratory failure, pneumonia)	16
Diabetes, renal failure	10
Other	1

Medical Products, Somerville, NJ, Dubbhoff PEG Kit, Order #14-7519-90) (Fig. 1). A retaining disc on the end of the tube was flexible enough to easily pull through the esophagus, but rigid enough to prevent accidental or intentional pulling through the stomach and abdominal wall. Marks were placed on the tube at 2, 4, and 6 cm from the retaining disc to allow visual confirmation of the disc's location within the stomach. A right-angle bend was placed 8 cm from the retaining disc so the tube could lie comfortably on the abdominal wall after placement. An external retaining disc could be adjusted to secure the stomach tightly against the abdominal wall initially, as well as more loosely during long-term use to prevent the tube from advancing into the stomach and out the pylorus. A nylon loop at the distal, tapered end of the tube allowed ready attachment to a pull wire and easy passage through the stomach and abdominal wall.

Procedure

Patients were given an intravenous antibiotic prophylactically on call to the operating room (1 g cefazolin sodium). General anesthesia was used in 74 patients because of patient agitation, spasticity, or because the patient was undergoing another operative procedure that required general anesthesia. The remaining 524 patients either received no anesthesia when poorly responsive, intravenous sedation if semi-alert, or a combination of topical anesthesia of the oropharynx and intravenous sedation if fully alert. When topical anesthesia was used, care was taken to use it sparingly to minimize the risk of aspiration of oral secretions after tube placement. The abdomen was cleansed with povidone-iodine soap, alcohol, and povidone-iodine solution and draped in a sterile fashion. A pediatric gastroscope was introduced orally and advanced into the stomach, examining the esophagus as the scope was advanced. Once the tip of the scope was in the stomach, air was insufflated to fully distend the stomach. During insufflation, the stomach and pylorus were examined for any abnormalities, especially for the presence of varices, active ulcerations, and gastric outlet obstruction. After inspection, a finger was gently pressed into the abdominal wall at the right upper quadrant just below the rib margin. The finger was subsequently moved over the abdominal wall until an indentation in the fundus midway between the greater and lesser curvatures was clearly seen through the gastroscope (Fig. 2). This usually resulted in the proposed skin exit site being one-third the distance from the midclavicular line at the rib margin to the umbilicus, although this point varied from a midline position to the anterior axillary line. The exit site was never allowed to be closer than 4 cm from the rib margin, because rubbing of the tube against the rib can be quite painful. A clear indentation of the stomach seen through the endoscope ensured that the stomach was adjacent to the abdominal wall and that neither the colon nor the small bowel was interposed (Fig. 3). Occasionally, the anatomy was confusing and better orientation was achieved by directing the endoscope anteriorly while darkening the operating room. Transillumination of light through the abdominal wall then allowed optimal positioning of the exit site using

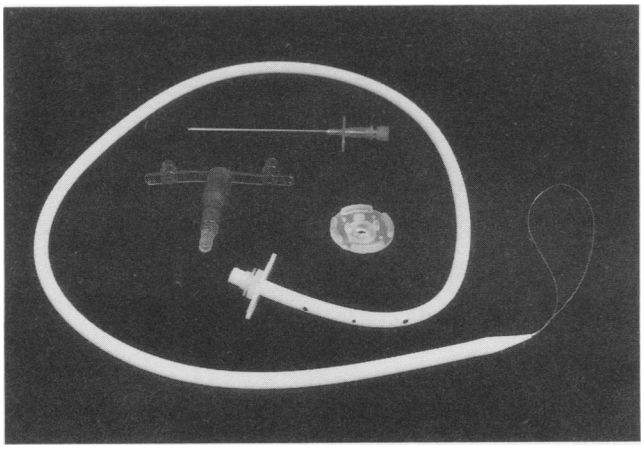

Figure 1. Percutaneous endoscopic gastrostomy tube with right angle bend and locator black marks.

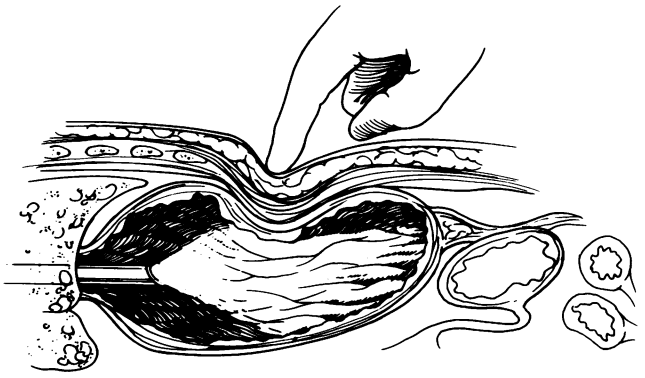

Figure 2. Indentation of the wall of the stomach by the finger as seen from within the stomach through the gastroscope.

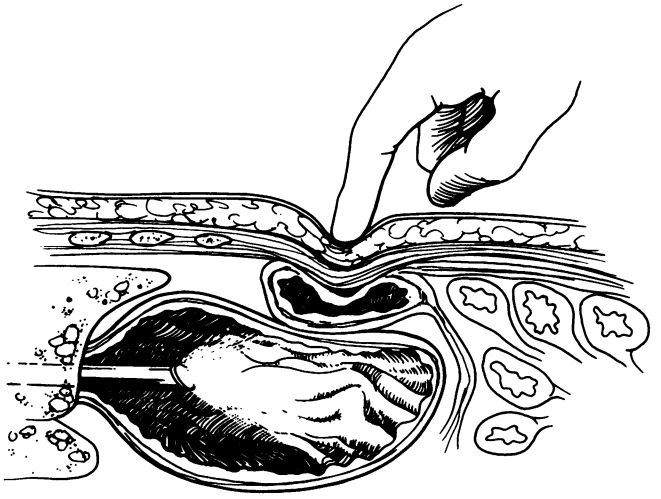

Figure 3. If bowel is interpositioned between the stomach and abdominal wall, the indentation will not be clearly seen.

the finger technique beginning where the transillumination was brightest. Clear visualization of a finger indentation of the anterior gastric wall was required before proceeding with tube placement.

Under local anesthesia, a transverse incision exactly 0.5 cm larger than the diameter of the gastrostomy tube was placed at the selected exit site. A larger incision delays wound healing, and a smaller incision limits drainage and increases the incidence of exit site infection. A trocar needle was passed into the stomach, confirmed visually through the gastroscope. A wire snare was passed through the endoscope, placed over the needle, drawn tight around the needle, and the trocar removed. A braided wire was passed through the needle into the stomach, the snare loosened, the needle removed from the abdominal wall, and the snare drawn tight over the wire. The gastroscope and snare then were withdrawn, drawing the braided wire out the mouth. The end of the wire was attached to the nylon loop of the polyurethane percutaneous gastrostomy tube. The tube was generously coated with Neosporin (Burroughs Wellcome, Research Triangle Park, NC) ointment as an antibiotic lubricant and the wire withdrawn from the exit site on the abdomen, drawing the gastrostomy tube down the esophagus and out the abdominal wall. Proper location of the gastrostomy tube was indicated by the marks placed at 2-cm intervals from the end of the tube. Usually the abdominal wall was 2 to 4 cm thick, leaving one or two marks visible (Fig. 4). Using these marks to confirm location of the tip of the gastrostomy tube within the stomach, there was no need to perform a second endoscopy. A disc retainer was passed over the end of the tube and tightened against the abdominal wall to firmly sandwich the stomach against the anterior abdominal wall. The disc was kept tight for 72 hours and then loosened to prevent erosion of the gastric wall or abdominal skin. (Note: With experience, the disc was not loosened until 5 to 7 days if the patient was severely malnourished or receiving steroids or immunosuppressive therapy.) Postoperative intravenous antibiotics were given for 24 hours (1 g cefazolin sodium every 8 hours). Feedings through the gastrostomy were begun 24 hours after placement. After 3 days, daily dressing changes were begun, painting the exit site with povidone-iodine solution and applying a gauze dressing. Showers and baths were permitted. Patients were followed until death or until the gastrostomy was no longer needed and removed.

RESULTS

Gastrostomy Placement

The average time required for percutaneous gastrostomy tube placement, from when the patient entered the operating room until leaving it, was 34.4 ± 13.7 minutes. The average endoscopy time was 4.2 ± 2.1 minutes. Only one intraoperative complication occurred: fracture of the lower alveolar ridge with loss of two carious teeth during attempts to open the mouth. All patients were monitored for cardiac arrhythmias and oxygen desaturation during endoscopy. No cardiac arrhythmias were observed. Twenty-one patients had episodes of oxygen desaturation below 90% (range, 72% to 89%) and all responded to oxygen supplementation and airway management. No patient required emergent intubation for airway management. Fourteen patients were markedly hypertensive on arriving in the operating room and responded to intravenous antihypertensive drugs.

Ninety-four patients had anatomic conditions that might complicate percutaneous placement of a feeding gastrostomy (Table 2). In only three patients, however, did these factors prevent placement of a percutaneous gastrostomy, requiring a laparotomy instead. One pa-

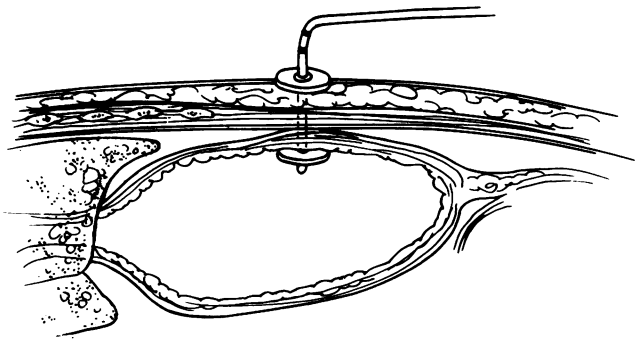

Figure 4. Correct position of the gastrostomy tube after placement with one or two of the three marks visible. The retaining disk has been tightened against the abdominal wall.

Table 2. MEDICAL PROBLEMS THAT COMPLICATE PLACEMENT OF PERCUTANEOUS GASTROSTOMY

Problem	No. of Patients
Obesity	33
Severe emphysema	15
Rigid jaw	14
High transverse stomach	6
Coagulopathy	5
Esophageal stricture	5
Severe contractures	5
Megacolon	4
Cirrhosis	4
Small gastric remnant	2
T-cell lymphoma of skin	1
Total	94

tient had a very small pouch following a previous gastric resection and neither the light transilluminated the abdominal wall nor could a finger indentation be seen. In another patient, the endoscope could not be passed into the esophagus because of previous oropharyngeal surgery. The third patient had an esophageal stricture that could not be adequately dilated. Four other patients with esophageal strictures were successfully dilated in the operating room to a size sufficient for passage of the endoscope and gastrostomy tube. Finger indentation was clearly seen in spite of morbid obesity in 33 patients. In eight obese patients, a 12-cm needle was needed for passage into the stomach because of the thickness of the abdominal wall. Six of the 14 patients with jaw rigidity required general anesthesia; the others responded adequately to short-acting intravenous sedation. The patients with megacolon or a high transverse stomach were at risk for colonic injury. In each case, exaggerated gastric distention with air displaced the colon enough so that a clear indentation of the stomach by the finger was seen and no colonic injury occurred. The 15 patients with severe emphysema suffered no hypoxia during gastroscopy with careful monitoring by anesthesia, appropriate endotracheal suctioning, and supplemental oxygen.

Two hundred eight patients had undergone previous intra-abdominal surgery (Table 3). In all but one, finger indentation was clearly seen after gastric insufflation, and the percutaneous endoscopic gastrostomy technique was performed without difficulty. In one of seven patients who had undergone prior partial gastrectomy, finger indentation could not be seen because of a very small gastric remnant, and an open jejunostomy tube was placed. Eleven patients with ventriculoperitoneal shunts underwent successful percutaneous gastrostomy. Care was taken to avoid the tract of the shunt catheter

Table 3. PRIOR ABDOMINAL OPERATIONS IN PATIENTS UNDERGOING PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

Procedure	No. of Patients
Hysterectomy	46
Appendectomy	38
Exploratory laparotomy lyses adhesions	25
Cholecystectomy	23
Ventriculoperitoneal shunt	11
Cystectomy with ileal loop	11
Repair abdominal aortic aneurysm	11
Colectomy	9
Partial gastrectomy (B-I or B-II)	8
Small bowel resection	5
Aortobifemoral bypass graft	5
Perforated duodenal ulcer	5
Splenectomy	4
Cesarian section	4
Pancreatectomy	1
Portocaval shunt	1
Repair diaphragmatic hernia	1
Total	208

during placement, referring to an abdominal x-ray taken the morning of surgery, or, in two cases, with use of intraoperative fluoroscopy. In no case was there any evidence for shunt infection during postoperative follow-up.

Complications

Twenty-nine complications occurred after placement of a percutaneous gastrostomy (4.9%) (Table 4). Twenty-two complications were minor (3.7%). There were 10 leakages about the gastrostomy exit site that occurred within 10 days after placement. All resolved with local

Table 4. COMPLICATIONS OF PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

No.	Complication
10	Leakage about gastrostomy site
5	Exit site infection (1 major)
5	Peritonitis (5 major: 1 died, 3 exploratory laparatomy, 1 antibiotics only)
3	Failures of placement
2	Aspiration pneumonia from endoscopy
2	Bleeding at gastrostomy site
1	Fracture alveolar ridge opening mouth (major)
1	Esophageal laceration on removal (major)
29	Total (overall, 4.9%; major, 1.3% [8])

dressing care. Occasionally a drainage bag was necessary when leakage was copious. Four minor episodes of exit site infection occurred at the gastrostomy exit site. In each case the patient had one or more infections elsewhere being treated with antibiotics at the time of gastrostomy placement (three with pneumonia, three with a urinary tract infection, and two with a wound infection). In addition, all had significant malnutrition likely compromising wound healing. Application of topical povidone-iodine ointment, intravenous administration of H-2 blockers, and antibiotics given through the feeding tube (500 mg cephalexin every 6 hours) resulted in resolution of the infection over 1 to 2 weeks. Two patients developed mild aspiration pneumonia after endoscopy, although no acute aspiration was observed during surgery. In both patients the pneumonia resolved with intravenous antibiotics. Two patients bled from the gastrostomy site as confirmed by endoscopy. One resulted in coffee-ground drainage, which cleared in 24 hours. The second bled more briskly but resolved with tightening of the disc for 48 hours. There were three failed attempts at placement. Although many patients were found to have pneumoperitoneum on a postoperative abdominal x-ray ordered for unrelated reasons, no episode of peritonitis was associated with the finding (Wojtowycz et al.[2] reported a 56% incidence of asymptomatic pneumoperitoneum).

There were eight major complications (1.3%). One serious exit site infection required local debridement. Five episodes of peritonitis occurred after placement of a percutaneous gastrostomy, which were thought to result from leakage from around the gastrostomy tube. In one patient, the disc was loosened in error the first postoperative night. The disc was retightened the following morning and peritoneal signs resolved with a course of intravenous antibiotics. In two patients, high-dose steroids were being given and no seal formed between the stomach and abdominal wall by 72 hours when the discs were loosened. Leakage occurred and peritonitis became evident. Both patients were taken to the operating room and underwent suture repair of the leak, suturing of the stomach to the abdominal wall at the gastrostomy exit site, and peritoneal lavage. Both survived with a functional gastrostomy tube. The fourth patient was severely malnourished. Peritonitis occurred on the third postoperative day before loosening of the disc. He was given intravenous antibiotics. His preoperative condition was very poor and the family declined further surgery. The patient died, and permission for an autopsy could not be obtained. The last patient was also severely malnourished. Her disc was left tightly compressed for 5 days and then released. Peritonitis developed over the next 24 hours. Surgical exploration demonstrated no seal between the stomach and the abdominal wall. The tube was removed and the stomach defect stapled. The patient recovered satisfactorily. One patient suffered a fracture of the alveolar ridge while attempting to open his mouth; he had very poor dental hygiene. Finally, one placement was complicated by an esophageal tear that resolved with observation.

Follow-up

Hospital stay after gastrostomy placement was variable, being dependent on the patient's primary disease. When the length of hospital stay was determined only by the placement of the gastrostomy tube, patients were discharged between 3 and 5 days after surgery. One hundred twenty patients died of causes unrelated to the gastrostomy tube between 1 and 972 days after surgery (75 ± 164 days) with the gastrostomy tube in place and still in use. Three hundred nineteen patients are still being followed from 134 to 2251 days after surgery (1533 ± 411 days). One hundred fifty-four patients have had the gastrostomy tube removed after 6 to 1337 days when it was no longer needed (169 ± 244 days). Removal was accomplished as an outpatient endoscopic procedure, grasping the end of the gastrostomy tube within the stomach with a snare, cutting the tube at the skin exit site, and drawing the intragastric portion of the tube out the mouth. All exit sites healed within 24 hours. No gastrocutaneous fistulas occurred. One esophageal laceration with transient bleeding occurred during tube removal. It healed spontaneously. No catheter required exchange because of deterioration. The polyurethane material did not become brittle or soft and did not lose its preformed shape. Five catheters were replaced because of accidental cutting of the tube close to the skin during home care. There were no erosions of the stomach or skin and no instances of catheter migration into the duodenum because the retaining disc prevented inward displacement.

Hypertrophic granulation tissue developed at the gastrostomy exit site in 22 patients. These were treated successfully in all but two patients with application of silver nitrate, usually requiring multiple applications. Two catheters were removed because of poor response of the hypertrophic granulation tissue to silver nitrate with a new catheter placed percutaneously through another skin exit site.

DISCUSSION

The average operating room time for placement of a percutaneous gastrostomy of 34.4 ± 13.7 minutes was significantly less that that required, in our prior experience, for placement of an open gastrostomy—96 ± 26 minutes ($p < 0.0001$).[3] Other reports have demonstrated similar time savings.[4–7] In addition to its speed, the percu-

Table 5. COMPLICATIONS OF STAMM GASTROSTOMY PER CENT INCIDENCE REPORTED

Author	No. of Patients	Years	No. Minor	No. Major	No. All
Connor[15]	125	1944–1954	10	4	14
Haws[16]	240	1950–1964	14	26	40
Parrish[17]	492	1956–1969	2	1	3
Wasiljew[18]	147	1974–1979	14	9	23
Shellito[19]	424	1975–1980	28	28	56
Wilkinson[20]	67	1972–1982	6	3	9
Grant[3]	88	1988	2	9	11
Samii[21]	83	1981–1985	23	2	25
Scott[22]	50	1984–1988	9	2	13
Total	1292				
Average			8.4%	6.5%	14.9%

taneous technique is associated with fewer complications. Table 5 summarizes published complications associated with placement of a Stamm gastrostomy. The average major complication rate of 6.5% and average overall complication rate of 14.9% are significantly greater than those published for percutaneous gastrostomy: major 2.8% ($p < 0.0001$) and total 8.8% ($p < 0.0001$) (Table 6); and those experienced in this series: major 1.3% ($p < 0.0001$) and total 4.9% ($p < 0.0001$). The speed and safety of percutaneous gastrostomy allowed placement of feeding access in very ill patients, simplifying their care, whereas many of these patients would have been considered too great a surgical risk for an open gastrostomy (in our series, 152 patients had an ASA risk ≥ 4).

Table 6. COMPLICATIONS OF PERCUTANEOUS ENDOSCOPIC GASTROSTOMY: PER CENT INCIDENCE REPORTED

Author	No. of Patients	No. Minor	No. Major	No. All
Ponsky[23]	307	2	2	2
Strodel[24]	45	0	16	16
Kirby[25]	55	8	2	10
Samii[21]	51	10	2	12
Hogan[26]	40	9	5	14
Sangster[27]	155	5	4	9
Kelly[28]	30	0	4	4
Hollands[10]	50	8	0	8
Miller[29]	330	7	7	14
Cellier[30]	30	5	0	5
George[31]	30	6	0	6
Scott[22]	50	5	0	5
Shike[32]	39	3	0	3
Saunders[33]	136	4	3	7
Gibson[34]	334	32	5	37
Aisenberg[14]	76	3	0	3
Total	1758			
Average		6.0%	2.8%	8.8%

Table 7. POTENTIAL COMPLICATIONS OF PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

- Aspiration pneumonia from endoscopy
- Esophageal laceration/perforation
- Hemorrhage at gastrostomy site
- Colonic perforation, gastrocolic fistula
- Leakage at gastrostomy site/peritonitis
- Exit site infection
- Tube dislodgement from stomach

Although the procedure of percutaneous endoscopic gastrostomy need not be performed in the operating room in low-risk patients, the high-risk patient with an ASA risk of ≥ 3 is certainly best served by the improved monitoring and airway management offered by an anesthetist in the operating room environment. In this series, 21 patients were observed to develop oxygen desaturation during endoscopy requiring supplemental oxygen and airway suctioning, 14 developed an acute stress-related hypertensive crisis requiring intravenous medications, and 74 were given general anesthesia. In addition, the potential complications of percutaneous endoscopic gastrostomy (Table 7) generally require surgical consultation and occasional intervention. Finally, failure of the endoscopic technique (3 instances in this series) can be addressed immediately in the operating room, converting to an open gastrostomy or jejunostomy. These factors favor the performance of percutaneous endoscopic gastrostomy as a surgical procedure.

Our success in placing a percutaneous gastrostomy tube in 207 of 208 patients with prior abdominal surgery confirms the experience of others.[8,9] There appears to be minimal risk in proceeding, even in patients with a partial gastrectomy, as long as finger indentation is clearly seen during endoscopy. If, however, an indentation is not seen, or if it appears to be blunted or diffuse, the procedure should be abandoned in favor of an open gastrostomy.

The use of perioperative antibiotics and application of an antibiotic lubricating ointment to the gastrostomy tube just before drawing it through the mouth and down the esophagus are important steps in minimizing peritonitis from any intra-abdominal soilage, as well as preventing local exit site infections.[10] To be effective, however, their use must be accompanied by proper surgical technique and gastrostomy care. The gastrostomy exit site should be 0.5 cm wider than the diameter of the

tube, large enough to allow ample drainage yet small enough to encourage healing. The discs approximating the stomach to the abdominal wall should be kept tight for at least 3 days to minimize gastric leakage and to allow adherence of the stomach to the abdominal wall, but no longer than 7 days to avoid pressure necrosis of the stomach or abdominal wall.[11-13]

The use of the polyurethane tube was found to have several advantages. The end disc was of such size and stiffness that no gastrostomy tube was pulled out or became dislodged "accidentally" at any time. This was a marked advantage as smaller or weaker bolsters have been associated with an incidence of 5% to 10% early dislodgement after tube placement, representing a major complication often requiring laparotomy because of peritoneal soilage. The inability to withdraw the tube had the minor disadvantage of requiring endoscopic removal when the tube was no longer needed. The markings on the tube provided assurance of the location of the tip of the tube within the stomach against the anterior abdominal wall. This feature eliminated the necessity for a second endoscopy and the associated risks of esophageal injury and aspiration as well as a reduction in operating room time. Others have likewise found marks to be of value.[14] Unlike prior experience with red rubber and Silastic tubes, the polyurethane tube did not undergo gradual deterioration, even when left in place up to 6.2 years. Routine exchange was not necessary.

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